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Earliest Wisconsinan Sediments and Soils

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ABSTRACT

The sediments and soils at the contact of the Illinoian and Wisconsinan Stages in the type region reveal that the Markham Silt Member at the base of the Roxana Silt resulted from the increased precipitation and decreased temperature that marked the beginning of the Wisconsinan Stage. Analyses of clay minerals, heavy minerals, and grain size were used in the study. Near the major valleys the Markham Member contains fresh loessial material from a source other than the underlying Illinoian deposits, indicating that Wisconsinan glaciers had reached the headwaters of the Mississippi River at least 75,000 radiocarbon years ago.

STRATIGRAPHIC IMPLICATIONS

The stratigraphic boundary between the Sangamonian and Wisconsinan Stages has been a point of controversy for many years (Frye and Willman, 1963a). In the type region, an agreement among several organizations and workers (Frye and others, 1968) defined the boundary at the contact of the Roxana Silt on the top of the Sangamon Soil, which developed in deposits of Illinoian age. The earliest deposits of the Roxana Silt are complex and contain at least two soils developed in thin units of sediments.

The Cottonwood and Pleasant Grove Sections were included as reference sections with the type definition of the Wisconsinan Stage (Frye and others, 1968). The sections are in valley bluffs, and the Roxana Silt is exceptionally thick in both (15 m and 12 m, respectively). Although mineral composition data have been

published for these thick loess sequences (Frye and others, 1962), and some clay mineral data have been published for the thinner Chapin (Willman and others, 1966), Reliance Whiting Quarry, and Literberry Sections (Frye and Willman, 1963b) away from the bluffs, more detailed mineral and textural analyses were needed for the critical basal units in the type region. The Jacksonville NW Section in NW$\frac{1}{4}$, SE$\frac{1}{4}$, NE$\frac{1}{4}$, Sec. 9, T. 15 N., R. 11 W., Morgan County, Illinois, was selected for such a study.

JACKSONVILLE NORTHWEST SECTION

Jacksonville NW Section, measured along east side of excavated pond, NW$\frac{1}{4}$, SE$\frac{1}{4}$, NE$\frac{1}{4}$, Sec. 9, T. 15 N., R. 11 W., Morgan County, Illinois, 1972.

Thickness (centimeters)

Pleistocene Series
Wisconsinan Stage
Woodfordian Substage
Peoria Loess

8. Modern Soil developed in loess; A2-horizon gray to gray-tan, platy, silty (P-7540, 21 cm below top); B1-horizon, well structured, tan-brown (P-7539, 38 cm); B2-horizon, red-brown, clayey (P-7538, 69 cm; P-7537, 99 cm). 135

7. Loess, leached, gray mottled with tan-brown in lower part, grading upward to tan-brown mottled with gray; B3-horizon in upper part (P-7536, 137 cm; P-7535, 168 cm; P-7534, 198 cm; P-7533, 229 cm; P-7532, 259 cm) 155

6. Loess, weakly calcareous; structure indistinct, platy to massive; gray mottled and streaked with light brown (P-7531, 290 cm; P-7530, 305 cm). 30

Altonian Substage
Roxana Silt
Meadow Member

5. Farmdale Soil developed in Roxana Silt; silt, pinkish brown, leached; platy structure (P-7529, 320 cm). 15

4. Loess, leached, pinkish tan to light reddish brown; platy structure and charcoal flakes in upper part (P-7528, 335 cm; P-7527, 396 cm). 130

McDonough Member

3. Silt, with some clay and sand, leached; gray-brown with mottles of tan-brown; a very few small pebbles; Pleasant Grove Soil developed in silt (P-7526, 465 cm; P-7525, 480 cm; P-7499, 495 cm) 40

Markham Member

2. Silt, clay, and sand with small dispersed pebbles, yellow-tan, light brown, and gray, leached; weak blocky and platy structure; Chapin Soil developed in silt (P-7498, 510 cm; P-7497, 526 cm; P-7496, 533 cm; P-7495, 541 cm) 35

	Thickness (centimeters)
Illinoian Stage	
Monican Substage	
Glasford Formation	
Hulick Till Member	
1. Sangamon Soil developed in till; B2-horizon, red-brown mottled with black and gray, clayey, leached, massive, tough, compact; grades downward to B3-horizon, leached, brown, massive; grades downward to C-horizon, gray-brown, massive, weakly calcareous (P-7494, 549 cm; P-7493, 579 cm; P-7492, 640 cm; P-7491, 701 cm; P-7756, 762 cm)	225
Total	765

The earliest stratigraphic subdivision of the Roxana Silt (Frye and Willman, 1960) is called the Markham Silt Member (Willman and Frye, 1970), which was earlier called Zone Ia by Frye and Willman (1963a). The Markham Silt Member was described in the Chapin Section, Morgan County, Illinois, where the total thickness of the Roxana Silt is only 2.6 m. The Markham Member is widespread throughout the north-central Midwest beyond the limit of Wisconsinan glaciation and ranges in thickness from less than 0.3 m to as much as 0.75 m. It is interpreted as resulting from the influence of the first cool episode of the Wisconsinan, and regionally it consists of a thin sheet of colluvium that overlies the Sangamon Soil, at many places at a plane of truncation. The sediment consists in part of the reworked materials of the A-horizon and, locally, the upper B-horizon of the Sangamon Soil, along with pebbles concentrated by erosion of the Illinoian till, which in places form a lag gravel. It also contains an admixed amount of earliest Wisconsinan loess in areas such as the central Illinois River Valley, where the earliest Wisconsinan glaciers reached the headwaters of the drainage—the Ancient Mississippi River at that time. The admixed loess introduced fresh minerals into the colluvial sediment that was slowly migrating across the surface.

In southeastern Illinois, on areas away from colluviating surfaces, the first thin Wisconsinan loess was additive to the Sangamon Soil and produced horizons that commonly display characteristics of an A-horizon, a B-horizon, or both. In such areas the weathered Roxana has been identified as the sandy silt facies of the Roxana Silt (Johnson and others, 1972). In east-central Iowa the sheet of colluviating material received no fresh loess, and its clay mineral composition, therefore, is similar to that of the underlying Sangamon Soil. It has been called the Late Sangamon paleosol in that area (Ruhe, 1956; Ruhe and others, 1965). In sharp contrast, along the Illinois River Valley where it has a recognizably different mineral composition, it is classed as the Chapin Soil developed in the Markham Silt Member of the Wisconsinan Roxana Silt.

A reversal towards a warmer and dryer climate at the end of the earliest Wisconsinan episode of colluviation and loess deposition allowed the stabilization of the colluvium and the development of the Chapin Soil. The mineralogical, textural, and morphological data show the Chapin Soil to be the first episode of soil formation in the Wisconsinan Stage.

The next wet and cool climatic event produced dominantly loess deposits that contained only a minor amount of till-derived materials. These deposits are referred to the McDonough Loess Member (Zone Ib) of the Roxana Silt. A short interval of equilibrium followed that allowed the development of the Pleasant Grove Soil. Above the McDonough Member lies the Meadow Loess Member (Zones II, III, and IV) of the Roxana Silt, deposition of which started at more than 40,000 radiocarbon years B.P. and was the major episode of Altonian loess deposition.

GENERAL CHARACTERISTICS OF THE SOILS

The Modern Soil at the Jacksonville NW Section is developed in the top of the Peoria Loess. The modern profile, a Typic Hapludalf, has a well expressed eluvial A2-horizon and an argillic B-horizon that has a maximum content of 36 percent clay at 69 cm, 26 percent more than that of the C2-horizon. The platy-structured A2 has a bleached appearance and grades downward into a dark yellowish brown (10YR 4/4), blocky B-horizon. The Peoria Loess becomes massive and more yellow and/or gray under the Modern Soil and contrasts with the pinkish brown Roxana Silt below.

The Farmdale Soil formed in the top of the Meadow Loess Member of the Roxana Silt. Soil horizons are poorly expressed, indicating a youthful or cold climate soil. The prominent features of the Farmdale Soil are the weak platy structure in the upper part, the absence of carbonates and textural contrast, the dark brown color (7.5YR 4/4) of the cambic B-horizon compared to the pinkish brown (9YR 4.5/4) of the C-horizon, and the sporadic occurrence in the A-horizon (the upper few inches of the soil) of black stains and carbonaceous materials.

The Pleasant Grove Soil in the McDonough Member is characterized by its subtle A-horizon characteristics and the brown color that distinguishes it from the overlying pinkish brown Meadow Member. Its solum is poorly expressed and to a large degree has merged with the underlying Chapin Soil. The platy structure and the bleached appearance of the Chapin A2 are more strongly developed than those of any other buried soil horizon except the Sangamon B2, and this development supports the identification of an A1-horizon in the Chapin Soil. The soils in the McDonough and the Markham tend to be dominated by A-horizon characteristics, but the lowermost horizon in the Markham displays B-horizon characteristics, particularly blocky peds coated with a yellowish gray silt. The lower McDonough and the upper Markham display both A- and B-horizon characteristics. Therefore, the top of the Chapin Soil is arbitrarily picked at a textural and heavy-mineral break (figs. 1 and 2).

Cross-cutting relations in the peds developed in this portion of the Markham and McDonough indicate that the B-horizon features are younger than the A2-horizon features. Slightly darker colored stains defining the surfaces of blocky peds, a diagnostic characteric of a B-horizon, cut across weakly expressed platy structure, which is characteristic of an A2-horizon. As new materials were added to the land surface, the soil profile grew upwards, leaving previous surficial material in a B-horizon-forming environment. These relations imply incremental deposition separated by periods of surface stability. The solum of the Chapin Soil is composed of two parent materials—the upper material is the Markham Member with a complex geologic and pedologic history, and the lower material is the truncated Sangamon Soil. Its morphology is similar to a present-day Alfisol, which is developed in thin loess overlying weathered till (truncated paleosol).

The Sangamon Soil developed in Illinoian till was truncated into the B-horizon, and a lag concentrate of pebbles accumulated on the surface of truncation. The B is reddish brown (5YR 4/4) and has a compacted, blocky structure with black stains and many thick clay skins along ped surfaces. Most of these characteristics are probably Sangamonian in age, although they were probably enhanced during development of the Chapin Soil.

COMPOSITION

Samples were studied by analyses of grain size, clay mineral composition (table 1), and the heavy mineral fraction (table 2). Size analyses were made by a standard pipette-sieving technique. The clay mineral compositions were calculated from X-ray diffraction data of the less than 2-micron fraction, using oriented aggregate techniques, for expandable clay minerals, illite, chlorite, and kaolinite. Expandable clay minerals here include all clay materials that expand to about 17 A when treated with ethylene glycol, and thus include montmorillonite (smectite) as well as any expandable chlorite or vermiculite.

The heterogeneity of expandable clay minerals (Willman and others, 1966), which serves as a measure of the modification that has taken place by weathering of material containing montmorillonite, has been called the heterogeneous swelling index (H.S.I.) (Frye and others, 1968) and is determined by measuring the vertical linear distance in millimeters from the commencement of the 17 Å diffraction peak to its maximum height. In general, the lower the H.S.I. value, the more weathered the material.

Heavy mineral separations were made by using standard bromoform procedures, although the coarse silt had to be stirred slowly to obtain a complete separation. The 0.42 to 0.063 mm sand was obtained by wet sieving and the coarse silt (0.063 to 0.031 mm) by decantation. A split from each sample was mounted in Canada balsam and then tabulated by the line point-count method. About 400 grains per slide were included, except for samples 7527 through 7532, which had an insufficient sand fraction. The percentage of fresh and weathered hornblende was determined on the coarse silt slides by counting about 400 hornblende grains per slide. Fresh grains are translucent and usually bounded by good longitudinal cleavage and cross fractures, modified by varying degrees of rounding, whereas weathered grains are etched, and some are also clouded by alteration products.

The sequence and stratigraphic placement of samples are shown in figures 1 and 2. In figure 1, the dotted lines for sand and gravel and for H.S.I. between samples 7526 and 7527 are based on a near-by sample from which the data were extrapolated. Figure 1 shows a sharp decrease in sand and gravel, an increase in H.S.I., a decrease of illite content, and a reversal in quantities of kaolinite and illite at the base of the Markham Member of the Roxana Silt where it is in contact with the truncated surface of the Sangamon Soil. Upward through the Markham and McDonough Members, the percentage of sand progressively decreases and approaches a constant value of about 2 percent in the Meadow Loess Member, which has the texture of loess. However, the percentages of illite and kaolinite remain much the same throughout the Roxana Silt, reversing sharply at the contact with the Peoria Loess. The H.S.I. shows maximum clay-mineral weathering in the Sangamon Soil, an intermediate degree in the Chapin and Pleasant

TABLE 1 - PARTICLE SIZE AND CLAY MINERALS, JACKSONVILLE NW SECTION

			Particle size (%)†				Clay minerals (%)‡		
Soil horizon*	Depth (cm)	Sample number	Gravel (> 2 mm)	Sand (2-0.06 mm)	Silt (0.06-0.002 mm)	Clay (< 0.002 mm)	Expand-able	Illite	Kaolinite plus chlorite
A2	21	P-7540	0	1	84	15	—	—	—
B1t	38	P-7539	0	1	72	27	61	25	14
B2t	69	P-7538	0	0	64	36	65	25	10
	99	P-7537	0	0	67	33	65	26	9
B3	137	P-7536	0	1	71	28	63	29	8
	168	P-7535	0	1	79	20	62	30	8
C1	198	P-7534	0	0	83	17	72	20	8
	229	P-7533	0	0	89	11	72	20	8
C2	259	P-7532	0	0	88	12	76	16	8
	290	P-7531	0	1	89	10	77	15	8
	305	P-7530	0	1	89	10	78	15	7
II A	320	P-7529	0	1	87	12	79	11	10
	335	P-7528	0	2	85	13	80	9	11
II C	396	P-7527	0	2	81	17	81	9	10
III A	465	P-7526	1	18	70	12	73	12	15
	480	P-7525	1	22	66	12	73	12	15
	495	P-7499	2	27	55	18	74	12	14
IV A1	510	P-7498	2	33	47	20	74	12	14
	526	P-7497	2	34	46	20	71	14	15
IV A2	533	P-7496	2	36	44	20	69	14	17
IV B1	541	P-7495	2	36	44	20	74	12	14
V B2	549	P-7494	17	41	36	23	50	29	21
	579	P-7493	2	45	33	22	51	27	22
	640	P-7492	1	64	15	21	53	32	15
V B3	701	P-7491	4	42	39	19	54	32	14
V C	762	P-7756	—	42	44	14	21	67	12

* Horizon designations used by USDA, buried soil horizon symbol, b, is deleted for convenience, and Roman numerals indicate change in geologic materials.

† Gravel percentage determined on total weight; sand, silt, and clay percentages are determined on the < 2 mm fraction.

‡ Determined on < 0.002 mm fraction.

Grove Soils developed in the Markham and McDonough Members, and lack of any weathering in the Meadow Loess Member. In the upper part of the Peoria Loess, the decrease of the H.S.I. shows the effect of the Modern Soil.

The heavy mineral data presented in table 2 permit derivation of a wide range of ratios and analytical approaches. However, it appears that measurements of the weathering of hornblende and the ratio of zircon plus tourmaline to hornblende [(z + t)/h] (fig. 2) in the coarse silt fraction provide the most meaningful evaluation of weathering and of the introduction of new sediments. However, the (z + t)/h ratio is meaningful as a measurement of weathering only if the materials being compared have the same original composition. At this section, textural, clay

TABLE 2 - HEAVY MINERALS, JACKSONVILLE NW SECTION

Sample number	Fraction* in sample - % by weight	Heavy minerals† in fraction - % by weight	Heavy minerals in fraction (percent by number of point counts)										Percent fresh hornblende of the total hornblende
			Ilmenite	Others‡	Epidote	Garnet	Zircon	Tourmaline	Rutile	Monazite	Staurolite	Total hornblende	
P-7532	38.0	5.2	9.3	19.6	17.3	2.5	1.7	1.7	0.1	0.4	—	47.4	79.0
	0.2	*tr*	*4.7*	*28.9*	*8.2*	*4.7*	*1.7*	*1.3*	—	*0.9*	—	*49.6*	
7531	33.1	4.0	12.5	22.8	16.8	2.4	1.5	1.2	0.5	0.6	—	41.7	79.9
	0.4	*tr*	*13.8*	*28.0*	*8.2*	*5.2*	*0.4*	*0.9*	—	*0.4*	—	*43.1*	
7530	34.5	4.7	14.0	17.7	18.1	4.4	2.1	2.1	0.8	0.5	—	40.3	81.8
	0.4	*tr*	*4.8*	*52.4*	*9.7*	*6.9*	*0.7*	*1.4*	—	—	—	*24.1*	
7529	35.5	4.6	14.9	23.1	16.4	3.2	1.7	1.2	0.1	0.6	—	38.8	72.2
	0.8	*tr*	*7.6*	*35.2*	*12.7*	*4.2*	*1.5*	*2.4*	*1.0*	—	—	*35.4*	
7528	39.9	4.5	19.7	26.2	16.5	2.0	2.4	1.2	0.3	0.1	—	31.6	81.0
	1.5	*1.0*	*8.0*	*35.4*	*8.9*	*4.7*	*1.1*	*2.9*	*0.8*	—	—	*38.2*	
7527	37.0	3.8	16.1	23.7	17.5	1.8	2.3	0.6	0.2	0.1	—	37.7	69.2
	2.3	*0.7*	*11.0*	*24.3*	*9.8*	*12.5*	*0.9*	*1.6*	*0.4*	—	*0.8*	*38.7*	
7526	32.3	3.4	13.1	23.0	22.7	3.6	3.2	1.0	0.6	0.1	—	32.7	53.5
	18.6	*0.7*	*18.3*	*20.2*	*10.7*	*12.3*	*2.6*	*1.9*	*0.2*	*0.2*	*0.2*	*33.4*	
7525	28.3	3.3	17.2	21.1	19.9	2.2	3.3	0.9	0.3	0.3	—	34.8	48.5
	22.6	*0.7*	*18.0*	*23.6*	*7.8*	*14.0*	*2.0*	*1.5*	*0.2*	—	—	*32.9*	
7499	22.4	2.4	13.3	30.9	20.2	2.1	3.4	2.8	0.4	0.4	—	26.5	46.0
	24.3	*0.6*	*13.6*	*19.1*	*12.7*	*17.9*	*1.4*	*1.7*	*0.6*	—	*0.3*	*32.7*	
7498	17.9	1.7	20.1	25.0	32.3	3.7	4.1	1.3	0.4	0.3	—	12.8	33.9
	33.4	*0.7*	*18.8*	*22.8*	*11.8*	*14.6*	*1.2*	*1.1*	*0.3*	—	*0.2*	*29.2*	
7497	16.4	1.9	17.2	30.7	28.5	2.3	3.4	2.2	1.2	—	—	14.5	36.1
	33.4	*0.7*	*18.0*	*25.5*	*10.3*	*12.8*	*1.9*	*1.4*	—	—	*0.4*	*29.7*	
7496	16.1	2.2	17.2	29.3	26.0	1.6	3.1	3.4	0.8	0.6	—	18.0	36.8
	31.6	*0.6*	*15.4*	*28.9*	*10.5*	*10.8*	*1.2*	*1.1*	*0.5*	—	*0.2*	*31.4*	
7495	16.6	2.8	13.2	30.3	21.8	1.6	3.7	1.8	0.8	0.4	—	26.4	39.0
	34.9	*0.7*	*19.8*	*16.8*	*12.4*	*14.8*	*2.4*	*2.8*	—	—	—	*31.0*	
7494	13.3	3.5	10.7	30.7	23.6	1.2	3.7	2.6	0.9	—	—	26.6	24.4
	39.9	*1.1*	*18.6*	*21.9*	*10.6*	*9.6*	*3.7*	*1.4*	*0.8*	—	—	*33.4*	
7493	11.1	2.2	16.1	22.9	19.6	2.6	3.7	2.9	0.6	1.5	—	30.1	37.4
	40.4	*0.7*	*15.9*	*23.1*	*14.1*	*14.2*	*0.8*	*1.4*	*0.1*	—	*0.2*	*30.2*	
7492	3.8	2.4	14.3	25.8	18.5	3.6	2.7	2.1	1.6	1.0	—	30.4	19.4
	62.6	*0.7*	*14.5*	*25.9*	*9.4*	*19.4*	*0.7*	*0.7*	*0.4*	*0.3*	*0.4*	*28.3*	
7491	14.6	2.4	10.2	23.6	19.1	7.2	2.0	2.9	0.2	0.3	—	34.5	36.3
	40.7	*1.6*	*17.3*	*18.7*	*7.5*	*19.0*	*1.2*	*1.8*	*0.6*	—	*0.4*	*33.5*	

* Two size fractions per sample, 1st row is 0.063 to 0.031 mm, 2nd row (italics) is 0.42 to 0.063 mm.

† Heating each fraction to about 90° C in a solution of 20% HCl and 2% $SnCl_2$ dissolved magnetite, iron oxides, and carbonate minerals.

‡ Includes all opaques except ilmenite, all microcrystalline and/or nearly opaque grains, pyroxenes, and trace amounts of other translucent grains.

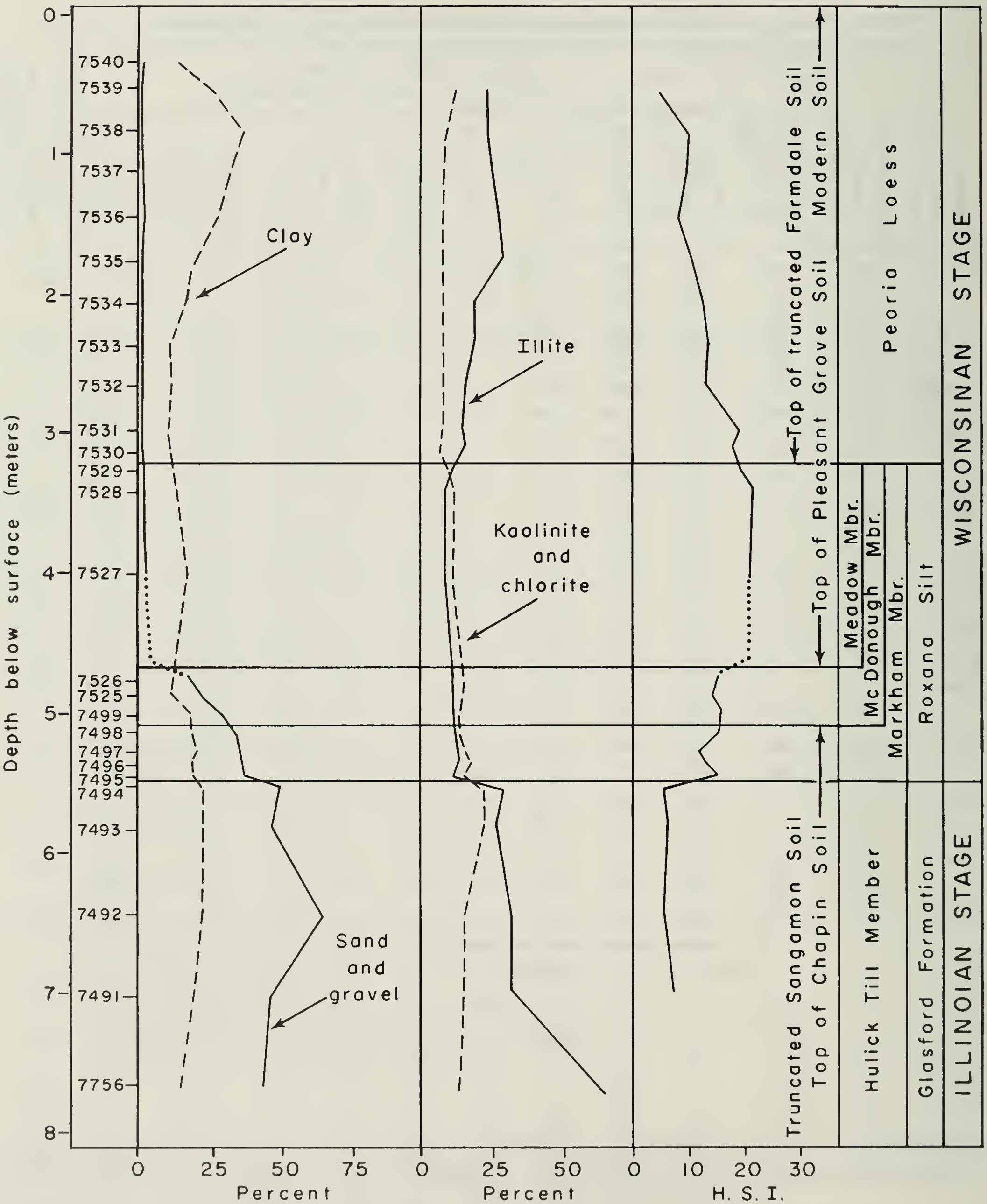

Fig. 1 - Graph showing significant elements of grain-size distribution and clay mineral composition at Jacksonville NW Section. Samples numbered on left side are in the "P" series, which is on file at the Illinois State Geological Survey. In the clay and H.S.I. curves, the dotted lines between P-7526 and P-7527 incorporate data from a near-by sample locality projected into this sequence. Numerical data are given in table 1.

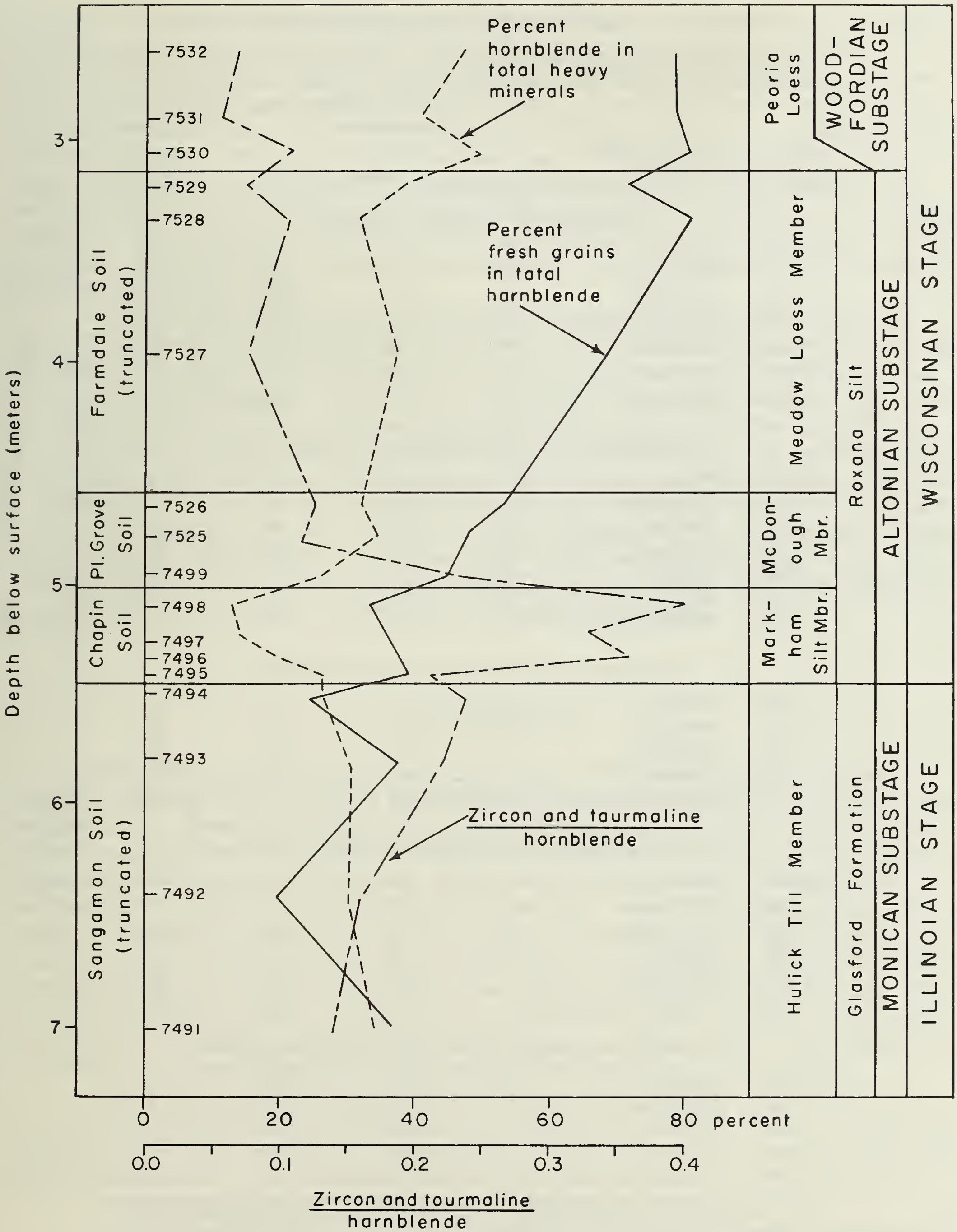

Fig. 2 - Curves showing variations of hornblende in the coarse silt fraction from the Jacksonville NW Section. Numerical data for this graph, and for all heavy mineral analyses for the section, are given in table 2. The samples numbered on left side are in the "P" series, which is on file at the Illinois State Geological Survey.

TABLE 3 - CLAY MINERAL DATA FOR MARKHAM AND McDONOUGH MEMBERS FROM FIVE COMPARATIVE SECTIONS*

Sample no.	Stratigraphic unit	H.S.I.	Clay minerals (%)		
			Expandable clay minerals	Illite	Kaolinite plus chlorite
	Chapin Section (Willman and Frye, 1970)				
P-2117	Meadow	16	70	13	17
2116	McDonough	12	60	20	20
2115	McDonough	10	59	18	23
2114	McDonough	9	59	20	21
2113	Markham	6	55	19	26
2112	Markham	4	54	21	25
2111	Sangamon-B	—	49	28	23
	Cottonwood School Section (Willman and Frye, 1970)				
P-7597	Meadow	23	79	12	9
7596	McDonough	16	73	18	9
7595	Markham	10	66	19	15
7594	Markham	10	67	18	15
7593	Markham	6	63	20	17
7592	Markham	2	50	30	20
7591	Sangamon-B	—	42	34	24
	Literberry Section (Frye and Willman, 1963b)				
P-1442	Meadow	9	75	11	14
1441	McDonough	4	58	15	27
1440	Markham	3	43	28	29
1439	Markham	—	47	28	25
1438	Sangamon-B	—	49	27	24
	Pleasant Grove School (Willman and Frye, 1970)				
P-7611	Meadow	25	78	15	7
7610	McDonough	16	71	20	9
7609	McDonough	11	65	22	13
7608	Markham	6	52	33	15
7607	Markham	5	49	35	16
7606	Sangamon-B	—	37	41	22
	Reliance Whiting Quarry Section (Frye and Willman, 1963b)				
P-1506	Meadow	17	67	18	15
1505	McDonough	11	57	24	19
1504	Markham	7	54	27	19
1503	Markham	7	43	34	23
1502	Sangamon-B	—	20	44	36

* Cottonwood School and Pleasant Grove Sections were resampled after sections were published and these sample numbers do not appear in the original report.

mineral, and heavy mineral discontinuities are present at the contact of the Markham Member on the Sangamon Soil. These discontinuities can be partially explained by weathering, but they also indicate a change in the materials that are related to the overlying members of the Roxana. The Chapin Soil has the highest (z + t)/h ratio and the lowest percentage of hornblende because it contains material derived partly from the Sangamon A-horizon. The intermediate percentage of fresh hornblende in the Chapin Soil indicates that fresh loess was added to the material derived from the Sangamon Soil. The increase in percentage of fresh hornblende upward through the McDonough Member is due to greater incoming amounts of loess. Interpretations based on percentage of fresh hornblende are consistent with the clay mineral data.

Clay mineral data from five previously studied and described sections (table 3) show the wide geographic distribution of the thin, distinctive stratigraphic units at the base of the Roxana Silt. As in the Jacksonville NW Section, the B-horizon of the Sangamon Soil is consistently more weathered than the overlying Markham and McDonough Members that contain the Chapin and Pleasant Grove Soils. This is shown by the absence of H.S.I. values and the low percentages of expandable clay minerals. The increase in H.S.I. and expandable clay minerals confirms the addition of new mineral material as the Markham Member was deposited. The increase in H.S.I. values from the Markham to the McDonough Member shows that the Chapin Soil is more weathered than the Pleasant Grove Soil. The Meadow Member above, which has the highest H.S.I. values and percentages of expandable clay minerals, is essentially unweathered loess.

CONCLUSIONS

The analytical data from the Jacksonville NW Section and clay mineral data from five additional sections substantiate several conclusions: (1) the Markham Member of the Roxana Silt, although in part colluvium derived from the upper part of the Sangamon Soil, contains a recognizable addition of admixed loess; (2) the composition of the loess component is the same as that of the overlying loess of the Roxana Silt; (3) a distinct soil, the Chapin Soil, was developed in the sediments of the Markham Member; and (4) although the percentage of fresh hornblende indicates that the Chapin Soil is less weathered and represents a shorter time than does the Sangamon Soil, it is probably the longest interval of soil formation within the Wisconsinan Stage. Evaluation of the duration of the interval during which the Chapin Soil formed is limited by the fact that the soil has not been available for study in a depositional unit thick enough to contain the entire profile.

The data substantiate placement of the base of the Wisconsinan Stage at the contact of the Markham Member of the Roxana Silt with the top of the truncated Sangamon Soil that developed in deposits of Illinoian age. This contact has been widely recognized in the Midwest and Great Plains regions, and it marks the change of climatic conditions from those of Sangamonian time.

In the type region it is still not possible to arrive at an accurate date for the beginning of Wisconsinan time. Radiocarbon dates place the base of the Meadow Loess Member of the Roxana Silt at more than 40,000 years. If the Pleasant Grove Soil consumed significantly less than the 15,000 years assigned to the Modern Soil, and if the interval of the Chapin Soil stability was about 15,000 years, we still do not have a measure of time for the colluvial episode of the

Markham Member or for the deposition of the McDonough Member. The extrapolated age of at least 75,000 radiocarbon years is still our best approximation for the beginning of the Wisconsinan Stage in the type region.

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